CONNECTICUT RIVER FLOOD CONTROL

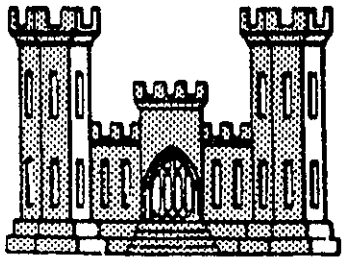
CONANT BROOK

DAM & RESERVOIR

CONANT BROOK, MASSACHUSETTS

DESIGN MEMORANDUM NO. 6

SITE GEOLOGY



U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

JULY 1963

407-362

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54. MASS.

ODRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO.

24 July 1963

NEDGB

SUBJECT: Conant Brook Dam and Reservoir - Conant Brook, Chicopee River Basin, Massachusetts - Design Memorandum No. 6, Site Geology

TO: Chief of Engineers
ATTN: ENGCW-E
Washington, D. C.

There is submitted herewith for review and approval Design Memorandum No. 6 - Site Geology for the Conant Brook Dam and Reservoir, Conant Brook, Chicopee River Basin, Massachusetts, in accordance with EM 1110-2-1150.

FOR THE DIVISION ENGINEER:

John Wm. Leslie

JOHN WM. LESLIE
Chief, Engineering Division

Incl (10 cys)
Design Memo No. 6 -
Site Geology

FLOOD CONTROL PROJECT

CONANT BROOK DAM AND RESERVOIR

CONANT BROOK

CHICOPEE RIVER BASIN
MASSACHUSETTS

Design Memo No.	Title	Submission Date	Approved
1	Hydrology and Hydraulics	29 Mar 1963	7 May 1963
2	Detailed Design of Structures		
3	Embankments and Foundations		
4	Concrete Materials	9 Nov 1962	23 Nov 1962
5	General Design	22 Apr 1963	31 May 1963
6	Site Geology	17 July 1963	
7	Real Estate		
8	Preliminary Master Plan		

CONANT BROOK DAM AND RESERVOIR

CONANT BROOK

CHICOPEE RIVER BASIN

MASSACHUSETTS

DESIGN MEMORANDUM NO. 6

SITE GEOLOGY

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LIST OF FIGURES AND PLATES

FIGURES

PLATES

CONANT BROOK DAM AND RESERVOIR

SITE GEOLOGY

JULY 1963

A. DESCRIPTION OF PROJECT

1. The Conant Brook Dam and Reservoir project is located approximately two miles south of the town of Monson, Massachusetts. As shown on the General Plan and Reservoir Map, Plate No. 6-1, the project consists of an earth and rockfill dam approximately 1050 feet in length, with a maximum height of 85 feet above streambed. A concrete ogee spillway, 100 feet in length and a 36-inch diameter, ungated conduit are located on the right bank. A low earthen dike approximately 980 feet long, with a maximum height of 14 feet above the stream, will be constructed along Munn Road at the upper end of the reservoir. Also included is the replacement, by wells or a storage pool, of that portion of the Monson water supply presently coming from two dug wells located in the proposed reservoir. Based on an exploratory program currently in progress, preliminary indications are that the required volume of potable water can be developed from a subsurface source.

B. GENERAL TOPOGRAPHY AND GEOLOGY

2. The area drained by Conant Brook and its tributaries is located in the western part of the Worcester plateau in a region of moderate relief. In general, the land surface lies between 500 and 1000 feet in elevation and is characterized by broad, steep-sided hills and poorly drained valleys. The topography is controlled largely by the underlying, folded and much altered, crystalline bedrocks, modified by glacial and post-glacial erosion and deposition. During the waning stages of the glacial period, as the ice front retreated across the region, the land surface was much altered by intermittent cycles of erosion and deposition resulting from an irregular and oscillating ice margin. The overburden materials are, therefore, commonly interlayered, variable in origin and composition, and with contacts which are often gradational. In the floor and along the sides of the major valleys, the materials are present as remnants of morainal debris, kame features, eskers, outwash and lake sediments. In general, these materials occur below elevation 600 feet but are present locally to an elevation of over 800 feet. Above these deposits, and in the smaller valleys, the slopes are blanketed with glacial till through which the bedrock outcrops rather extensively at the higher elevations.

C. DESCRIPTION OF SITE

3. Dam Site. Conant Brook enters the project area from the east and at the damsite is flowing in a narrow valley, the wooded slopes of which rise sharply from a small flood plain. Downstream of the project centerline, the flood plain is occupied by the extremity of a small water supply reservoir. The left or south abutment is formed by a large, steep-sided, glacial till and bedrock hill rising to a height of some 175 feet above the river. Bedrock is exposed high on the east flank of the hill but lies deeply buried in the abutment area. The right or north abutment feature has a somewhat gentler slope which rises to a height of about 100 feet above the river. This abutment is bedrock controlled, with outcrops present above elevation 750 feet and along the river bank at elevation 690 feet. Elsewhere on the right abutment overburden is relatively thin. The floor of valley, which is occupied by thick deposits of glacial and glacio-fluvial materials, is approximately 150 feet in width at the project centerline.

4. Dike Site. The proposed dike is located approximately one mile upstream of the damsite, where Munn Road crosses the valley on a low drainage divide having a crest elevation of approximately 750 feet. At this point the valley floor is some 1000 feet in width and is choked with large amounts of morainal debris and glacio-fluvial materials. Remnants of these materials, the surfaces of which stand slightly above the general level of the valley floor, lie along both sides of the valley and will form the abutments for the proposed dike. The central portion of the valley floor in this area is occupied by a rather extensive swamp.

D. SURFICIAL AND SUBSURFACE INVESTIGATIONS

5. Previous Investigations. Geologic reconnaissance and nine foundation explorations comprising five borings, three test pits and one test trench were made by the Corps of Engineers in 1958 for preparation of an interim survey report entitled Chicopee River Basin, Massachusetts.

6. Current Investigations. Forty-nine foundation borings, supplemented by detailed geologic reconnaissance and mapping, were completed by the Corps of Engineers for final design. Thirty-two of these borings were made at the damsite during the period July - December 1963. Bedrock data developed by the borings in the spillway area revealed that the most desirable foundation conditions for siting of the spillway were just downstream of the initially proposed siting. Accordingly, the dam and spillway alignments were adjusted to take advantage of this condition.

During the period February - April 1963, fourteen additional borings were made to develop detailed information at the new spillway location, discharge channel and outlet works. At the same time three borings were made at the dike site.

7. The locations of all of these explorations are shown on the Plan of Foundation Explorations, Plate No. 6-2. All borings were made by continuous drive-sampling methods in overburden and, where encountered, bedrock was diamond-drill cored with NX (2-1/8" diameter core) bits and maximum recovery type core barrels. Hydraulic pressure testing of the rock was conducted in borings at structure locations and on the right abutment where the embankment cut-off will extend to rock. Detailed classification and description of materials encountered in all foundation explorations, and all pressure test data are shown on the Records of Foundation Explorations, Plate Nos. 6-6 through 6-9.

E. FOUNDATION CONDITIONS

8. Damsite. Bedrock is present at shallow depth throughout much of the right abutment beneath a generally thin cover of glacial and glaciofluvial materials through which it outcrops locally. The rock surface dips steeply beneath the valley floor where it is overlain by a substantial thickness of glacial till, outwash and lake deposits. In the left abutment, it is buried beneath a thick deposit of glacial till. Exploratory data revealed extensive interlayering of overburden deposits, considerable intermixing of materials, much discontinuity of individual layers and an associated variability in the vertical sequence.

9. Overburden. While foundation conditions relative to the overburden materials do not appear to present any unusual engineering problems, they are difficult to describe. This is particularly true of the deposits in the valley floor which are thick, interlayered and frequently intermixed along the contacts. This condition makes both vertical and horizontal correlation difficult, as well as the establishment of relationships between materials in the valley floor and those in the abutments.

10. Overburden materials on the right abutment consist principally of loose to compact, locally sorted, variably silty sands and gravels with numerous cobbles and, in some places, sections of occasionally stratified fine sands and silt. These materials differ locally in mode of origin, but because of intermixing along many of the contacts, differentiation is difficult. They can, therefore, be best treated generally as one unit. These materials range from a few feet to over 25 feet in thickness and average 10 feet, with maximum accumulations occurring near the toe of

the abutment upstream of the survey base line and at the lower end of the spillway discharge channel. Generally speaking, the materials which overlie bedrock and, which constitute the surface materials downstream of the survey baseline, are considered to consist of till and till-like deposits. Upstream of the baseline, these materials are overlain by some 10-feet of materials considered to be outwash, principally because they are somewhat sorted, less silty and contain sections of relatively clean sand and gravel.

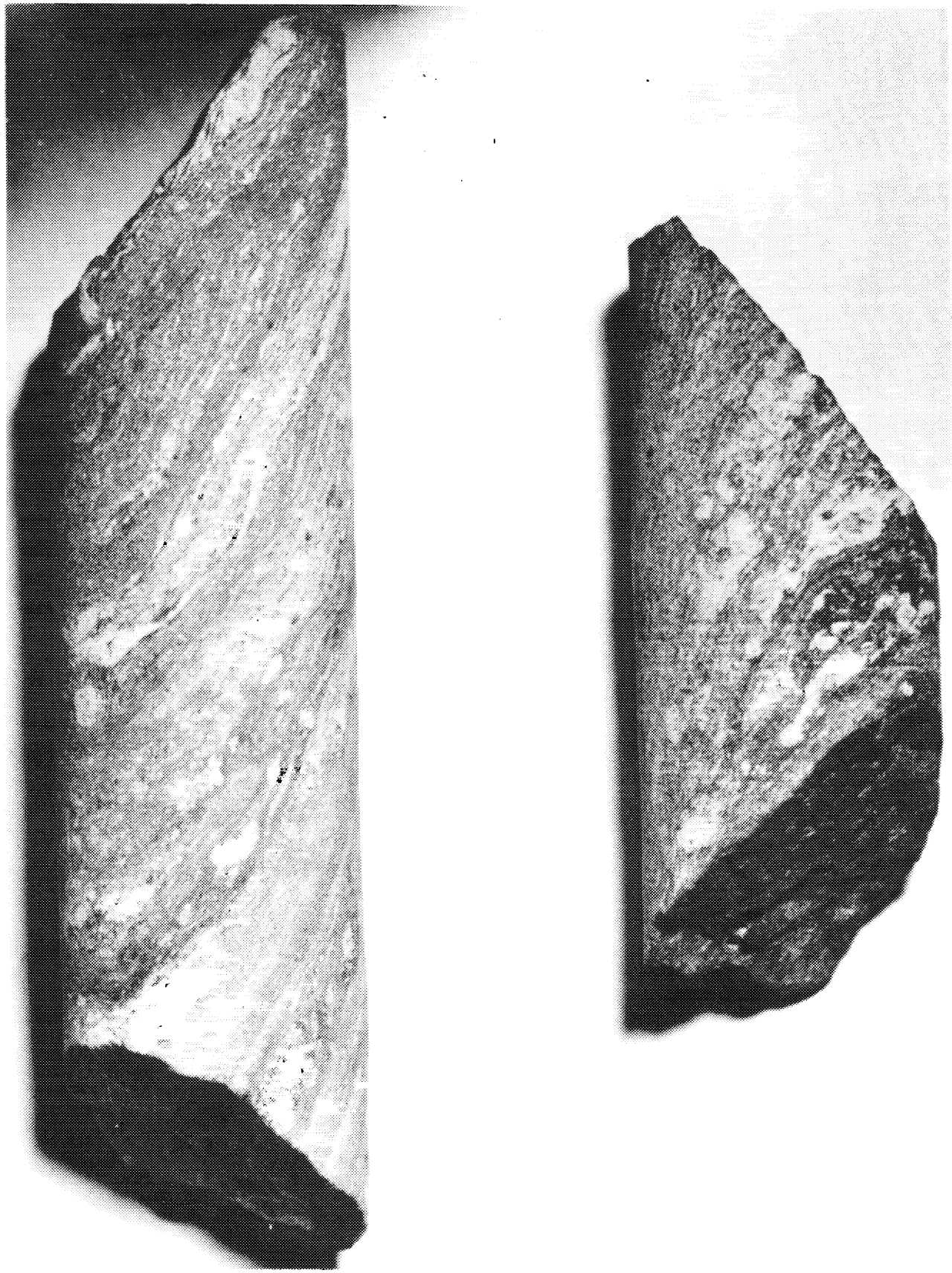
11. Materials in the valley floor are similar to those described above but with the addition of lake sediments and limited amounts of recent alluvium. These materials range from 25 to over 50 feet in thickness and average 40 feet, with maximum accumulations occurring along the left or south side of the valley. In the area downstream of the survey base line, the materials consist principally of two layers or zones of till, separated by some 10 feet of relatively clean sands and gravels, with cobbles and boulders. The till in the two zones is similar in composition, consisting of silty gravelly sand with cobbles. However, the lower till is compact and bouldery while the upper is relatively loose and free of boulders. The surface of the sand and gravel interlayer lies between 15 and 20 feet below ground surface in this area. In the area upstream of the survey base line, correlation is more difficult and the sequence less defined, varying markedly from boring to boring. The sequence of materials described above is traceable upstream to the vicinity of boring FD-23. At this point, however, the interlayer is only 5 feet thick and includes stratified silt and sand, while the lower till is somewhat clayey. Furthermore, the entire sequence is underlain by some 18 feet of lake sediments which consist of layers of silt, silty fine sand and silty sand and gravel in descending order. To the north or riverward, the upper till is missing and the lower till, which rests on bedrock, is overlain by some 10 feet of relatively clean outwash sands and gravels. Upstream or easterly, the sediment sequence persists but thins, the tills disappear and are replaced by outwash materials which increase to some 20 feet in thickness.

12. Overburden materials on the left abutment consist entirely of glacial till ranging from 15 to over 80 feet in thickness and averaging 45 feet, with maximum accumulation occurring in the vicinity of boring FD-31. These materials consist principally of gravelly silty sand with occasional seams of silty fine sand and numerous cobbles. On the upper abutment the top 10 to 15 feet is brown in color, moderately compact and quite sandy, with occasional layers of silt and clay. Below this depth, and throughout the full depth in the lower abutment, the material is generally grey in color, compact to very compact, and locally clayey and bouldery.

13. With respect to the overall picture, it appears that a continuous layer of glacial till overlies bedrock across the entire site at the project centerline. Secondly, the sand and gravel interlayer, resting between the tills in the valley floor, fingers into the right abutment materials, is cut off sharply along the left or south side of the valley floor and tapers out upstream, disappearing completely somewhere between the survey baseline and the upstream toe of the dam. Thirdly, there is a depression or trough in the bedrock surface, trending roughly east-west along a line through FD-7 in the valley upstream of the dam and FD-31 on the lower left abutment. Finally, extensive outwash deposits, capped locally by alluvium, constitute the surface materials over much of the valley floor and right abutment upstream of the survey baseline.

14. Bedrock. Bedrock in the site area consists of a much injected and altered garnetiferous mica schist, characterized by rather extensive surface weathering. The attitude of these rocks, determined from outcrops, shows an apparent strike of North 17 to 22 degrees west, approximately normal to the river, and a foliation dip ranging from 40 to 85 degrees west, roughly downstream. In general, the rock surface, which is rather irregular, dips southerly behind the face of the right abutment, and under the valley floor, then rises again behind the left abutment. Quite generally the rock is typified by a locally contorted, highly variable, thin foliation, many of the planes of which are filled with stringers and veins of quartz and feldspar. Small pods or phenocrysts of feldspar are also common throughout much of the rock. In a few places, there is evidence of granitization with, in a few instances, some semblance of gneissic structure.

15. Structurally the rock, except for the top 5 to 10 feet, is generally hard and sound though closely jointed and variably fractured. Figure 1 shows typical cores of sound rock. For the most part the top 5 to 10 feet is highly jointed and fractured, variably open with some silt filling, and moderately to severely weathered. Below this zone weathering is generally confined to open joint and fracture planes and foliation partings. Slickensiding, rock gouge and secondary mineralization characteristic of slippage or movement, was observed in the cores from borings FD-35 near the conduit intake structure, FD-28 and FD-29 in the spillway approach channel and FD-17 and FD-21 along the outboard side of the spillway discharge channel. While this appears to be a localized condition in the two downstream holes, there may be a shear zone extending along, a line between FD-35, and FD-28 and FD-29, which line roughly parallels the strike of the foliation of the rock. Detailed descriptions of cores are given on the Records of Foundation Explorations, Plate Nos. 6-6 through 6-9 and Geologic-Log Sections, Plate Nos. 6-3 through 6-5.



CORES OF TYPICAL SOUND MICA SCHIST
SHOWING PARTINGS ON FOLIATION AND ON JOINTING

DM NO. 6 CONANT BROOK DAM FIGURE I

16. Hydraulic pressure testing was conducted in borings at structure locations and along the right abutment portion of the survey baseline. Water losses on the order of 5 to 15 GPM at pressures of 10 to 20 psi were recorded to depths of up to 20 feet below the bedrock surface, indicating a rather open condition in this zone. Below the top 20-foot zone, losses were negligible or nil at 30 to 50 psi. Zones tested and the losses recorded therein are graphically shown on the Records of Foundation Explorations, Plate Nos. 6-6 through 6-9 and Geologic-Log Sections, Plate Nos. 6-3 through 6-5.

17. Dike Site. Overburden deposits at the dike site are comprised principally of glacial outwash which occupies most of the valley floor. Adjacent to the stream, the materials consist almost entirely of moderately clean to clean medium to fine sands to a depth of over 40 feet. At the top of these sands is a 1 to 7 foot thick section of clean gravel which is overlain by some 6 feet of swamp deposits consisting of peat, sandy organic silt and silty sand. To the north, where the ground rises slightly, the materials become gravelly throughout, and the surface material is limited to fine sandy silt. The north or right end of the dike will tie into the face of a 10 foot high remnant of outwash sands and gravels, while the south or left end will tie into an esker feature composed of dirty sands and gravels.

F. SUBSURFACE WATER

18. Levels of subsurface water were observed in many of the borings during drilling operations and are indicated by symbol on the Records of Foundation Explorations. Levels in and adjacent to the valley floor occur in the overburden, at or slightly above the level of the river. In the right abutment the levels are somewhat variable. In the outwash area upstream of the centerline, levels occur generally in the overburden up to approximately elevation 755 feet. Above this elevation they are either close to or slightly below the bedrock surface. Downstream of the centerline, the levels occur generally at depths of 10 to 15 feet below the bedrock surface. No true levels of subsurface water were established in the glacial till in the left abutment.

G. RESERVOIR LEAKAGE

19. A permanent storage pool is not presently contemplated as a part of this project. The flood control reservoir is nearly surrounded by massive till and bedrock hills through which leakage is not anticipated. Both spillage and leakage will occur at the easterly extremity of the reservoir, however, through a low drainage divide. This will be controlled by the construction of a low earthen dike across the divide. Some leakage will

occur through the overburden and upper 10 to 20 foot zone of highly jointed and fractured rock beneath the dam and appurtenant structures. This will be controlled by a cut-off trench through the overburden on the right abutment and across the valley floor, supplemented by area and curtain grouting in the rock.

H. CONSTRUCTION MATERIALS.

20. General. The proposed embankment for the dam will consist of compacted impervious fill upstream and random fill downstream, composed of glacial till materials from borrow excavations. The impervious material will be blanketed with rock fill and the random with protection stone, both of which will be obtained from required excavations. Gravel bedding and internal drainage features consisting of a wick, downstream drainage blanket and trench, will be constructed of pervious materials to be furnished by the contractor. An upstream cut-off and grout curtain will provide additional seepage control. The proposed embankment for the Munn Road Dike will be topsoiled and seeded, and will consist entirely of random material obtained largely from required excavation.

21. Impervious and Random Materials. Materials suitable for the construction of the impervious and random sections of the dam, and the relocated Wales Road, are available in required quantity from a borrow area established above the height of dam on the left abutment as shown on the General Plan and Reservoir Map, Plate No. 6-1. These materials comprise a variable deposit of glacial till which can be divided into two zones, upper and lower, based on the composition and degree of compactness. Figure 2 shows an excavated section of the glacial till. The 7 to 10 foot thick upper zone consists of brown to gray, gravelly silty sand with numerous cobbles. The upper material will be used to construct the random fill sections of the embankments. The lower zone, which is 10 to over 30 feet in thickness, consists principally of gray, compact to very compact, silty medium to fine sand, with occasional sections of gravelly silty sand and cobbles. This material will be used to construct the impervious fill section of the dam embankment. From observations made in an exploration test trench, and in observation wells over a period of 6 months, it appears that the subsurface water level in this area varies from 10 to 30 feet below ground surface following the slope of the hill. Some water is also believed to be perched on the top of the lower zone of the till. The hillside position of the area will facilitate drainage during excavation.

22. Pervious Materials. All pervious materials required for construction of the internal drainage features of the dam will be furnished by the contractor. Adequate supplies of suitable materials are available from a

BORROW AREA FOR RANDOM AND IMPERVIOUS EMBANKMENT FILL MATERIALS
EXPLORATORY TEST TRENCH IN GLACIAL TILL

DM NO. 6 CONANT BROOK DAM FIGURE 2

number of undeveloped and commercial sources within a 2 to 10 mile radius of the project.

23. Rock Fill. Rock from required excavation will be generally suitable for construction of rock fills and for slope protection. Total rock excavation quantities are large enough, to assure the availability of the required volume of suitable rock. Perhaps some 5 percent of the excavated rock will be unsuitable for use in embankment construction, most of which will come from the highly jointed and fractured top 10 feet, and from slabby fragmentation due to foliation breakage. The close jointing and fracturing prevalent in much of the rock, should produce a fairly well graded material. A bulking factor of approximately 30 percent is assumed, with some reduction from handling, trafficking, and from stockpiling and rehandling.

24. Concrete Aggregate. An estimated 3000 cubic yards of concrete will be required for spillway, walls and conduit. In view of this small volume of concrete, aggregates will be obtained commercially by the contractor. Complete data on available sources and tests on the materials are contained in Design Memorandum No. 4, Concrete Aggregates, Dated November 1962.

I. CONCLUSIONS AND RECOMMENDATIONS

25. In the formulation of these conclusions and recommendations, full consideration is being given to all geologic factors bearing on excavations, foundations and leakage. Materials suitable for use in construction of the major portions of the dam and dike are available from required excavations and from a borrow area established on the upper left abutment at the dam. Special materials for the drainage features of the embankments and aggregates for concrete will be obtained from commercial sources.

26. In accordance with established practice of the Division, a digest of geologic factors pertinent to the design and construction of the project will be furnished to field construction personnel for information, guidance and instruction for the work. This digest will point out the availability of geology personnel for field consultation, at the outset and during major or critical excavations and grouting operations.

27. A closely spaced joint and fracture pattern, particularly in the variably weathered top 10 to 15 feet, and a thin, westerly dipping foliation, are the most significant characteristics of the rock in the project area. These characteristics will greatly influence ultimate excavation slopes and extent of grouting required for seepage control. In general.

excavation lines will intersect the structural trend of the rock at an angle of approximately 50 to 70 degrees. Extreme care will be required in excavations along the southerly or outboard side of the spillway cut, particularly in approach to foundation grade for the concrete gravity wall. Rock cuts along the right or landside of the spillway will average slightly less than 20 feet in depth, and about 10 feet on the outboard side. Due to the shallowness of cut, much of the excavation generally, and all of it along the outboard side, will be in the zone of badly fractured and variably weathered surface rock. Unavoidable overbreak is to be expected in this zone. Because of this generally poor condition of the surface rock encountered in spillway explorations, further study of the spillway channel and weir is being made. Rock cuts for the conduit will average less than 7 feet in depth, and from the intake structure downstream for some 150 feet to about Station 5+00, will be only 2 to 5 feet. At the location of boring FD-41, sound rock occurs about one foot below conduit invert elevation. Some sub-invert excavation and concrete backfill will be necessary in the first 150 feet and preservation of side slopes in this reach is not possible. Downstream of this area preservation of side slopes, including in part the outboard side, will be possible.

28. Overburden and loose rock will be removed for a distance of 10 feet back from the face of all rock cuts as a general safety measure. Thorough scaling will be required on all rock faces, and safety mesh, fastened with rock bolts, will be used where applicable and necessary.

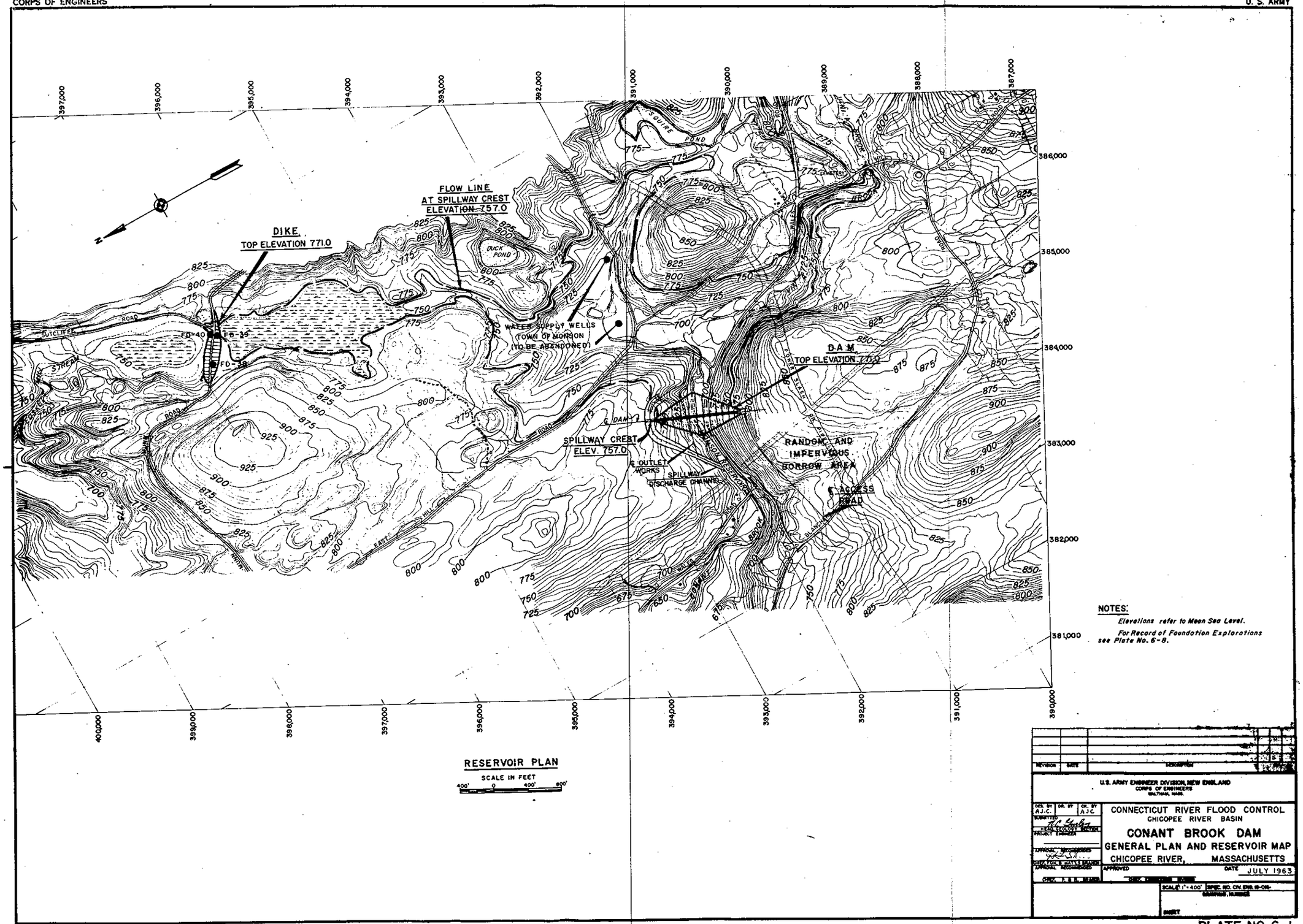
29. The specifications will require that the contractor perform trial excavations in short sections of the conduit and spillway to determine plans of drilling and blasting best suited to preservation of side rock, and also to production of backfill and slope protection as may be compatible. Line drilling will be employed in areas of critical excavation, not so much for line drilling results, but as a method for best possible preservation of side and foundation rock.

30. Hydraulic pressure test data and rock cores from exploratory borings reveal that grouting, particularly of the top 10 to 20 feet of rock, will be necessary to aid in the control of seepage and reduction of uplift. A grout curtain will be constructed beneath the weir and throughout the full length of the cut-off where made to the rock surface. Need for area grouting in the cut-off trench will be governed by results of initial grouting and the condition of rock as exposed, with consideration to seepage control in the embankment design.

31. Normal rock excavations are expected to produce generally sound, well-graded material of suitable size and shape for use in rock fill and as slope protection. Machine cleaning of rock surfaces to be excavated will be required in order to reduce contamination of blasted rock.

CORPS OF ENGINEERS

U. S. ARMY



RESERVOIR PLAN

SCALE IN FEET

400' 0 400' 800'

NOTES:

Elevations refer to Mean Sea Level.

For Record of Foundation Explorations see Plate No. 6-8.

REVISION	DATE	DESCRIPTION

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY A.J.C.	DR. BY	CK. BY A.J.C.

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

CONANT BROOK DAM
GENERAL PLAN AND RESERVOIR MAP

CHICOPEE RIVER, MASSACHUSETTS

APPROVED DATE JULY 1963

SCALE 1"=400' SPEC. NO. CIV. ENG. 19-016-

PLATE NO. 6-1

CORPS OF ENGINEERS

U. S. ARMY

PLAN

1" = 40'

0 40' 80'

LEGEND

- FD Foundation Test Boring
- FT Foundation Test Pit
- FTT Foundation Test Trench
- Bedrock Outcrop
- Boulder
- Location and direction of view for Geologic-log Section
- N 17° W / 70°-85° W Strike and dip of foliation

NOTES

Elevations refer to Mean Sea Level Datum.
Contour interval is 2 feet.
For Record of Foundation Explorations, see Plates No. G-6, G-7, G-8 and G-9.
For Geologic-Log Sections See Plates No. G-3, G-4 and G-5.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY C.A.M.	DR. BY R.D.B.	TC. BY R.C.G.

SUBMITTED
CHIEF, GEOLOGY SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, FOUNDATION & MATLS. BRANCH
APPROVAL RECOMMENDED
CHIEF, E.D.P. BRANCH

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

CONANT BROOK DAM
PLAN OF FOUNDATION EXPLORATIONS
CHICOPEE RIVER, MASSACHUSETTS

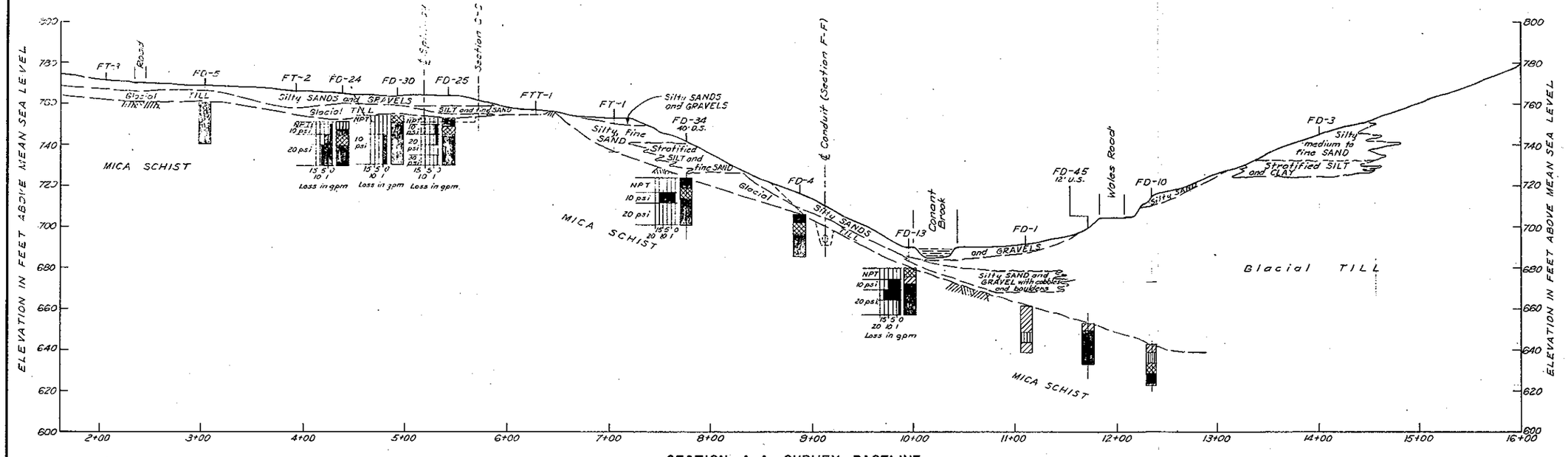
APPROVED
CHIEF, ENGINEERING DIVISION
DATE JULY 1963

SCALE AS SHOWN SPEC. NO. CIV. ENG. 19-ONE-
DRAWING NUMBER
SHEET

PLATE NO. 6-2

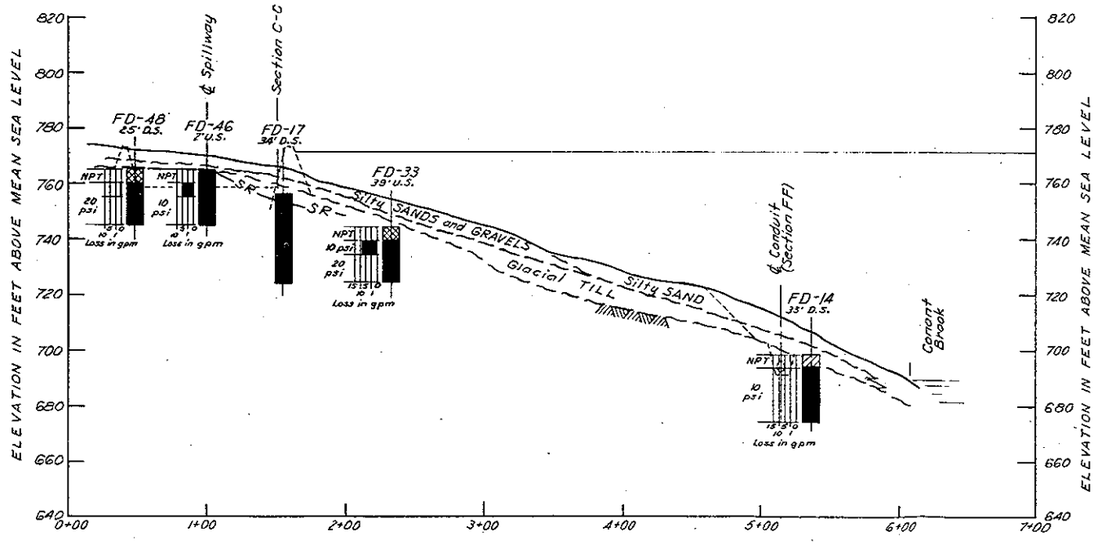
CORPS OF ENGINEERS

U. S. ARMY



SECTION A-A SURVEY BASELINE

(LOOKING UPSTREAM)

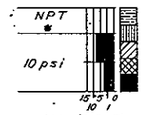


SECTION B-B RIGHT ABUTMENT - CENTERLINE OF DAM

(LOOKING UPSTREAM)

LEGEND FOR CORE BORING IN ROCK

FD-1 Foundation Test Boring



- Rock core recovery 0-25%
- Rock core recovery 25-50%
- Rock core recovery 50-75%
- Rock core recovery 75-90%
- Rock core recovery 90-100%

NPT — No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.

10 psi — Constantly maintained pressure for 1 to 5 minutes. Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections. Scale expanded from 0 gpm to 1 gpm for clarification of low flow losses.

Assumed Rock Surface

— SR — Assumed Sound Rock

NOTES

The glacial till consists principally of gravelly silty sand containing numerous cobbles and occasional boulders. Included also are substantial sections of silty sand, thin layers of silt and clay, and seams of relatively clean sand. The till grades with depth from brown, moderately compact to gray, very compact.

For Record of Foundation Explorations, see Plates No. 6-6, 6-7, 6-8 and 6-9.

For Location of Geologic-Log Sections, see Plate No. 6-2.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY C.A.M.	DR. BY R.D.B.	CK. BY R.C.G.
SUBMITTED: HEAD, GEOLOGY SECTION		
PROJECT ENGINEER		
APPROVAL RECOMMENDED: CHIEF, PLANS & SPEC'S BRANCH		
APPROVAL RECOMMENDED	APPROVED: CHIEF, ENGINEERING DIVISION	DATE: JULY 1963

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

CONANT BROOK DAM
GEOLOGIC-LOG SECTIONS - DAM

CHICOPEE RIVER, MASSACHUSETTS

SCALE AS SHOWN (SPEC. NO CN. ENG.-78-016)

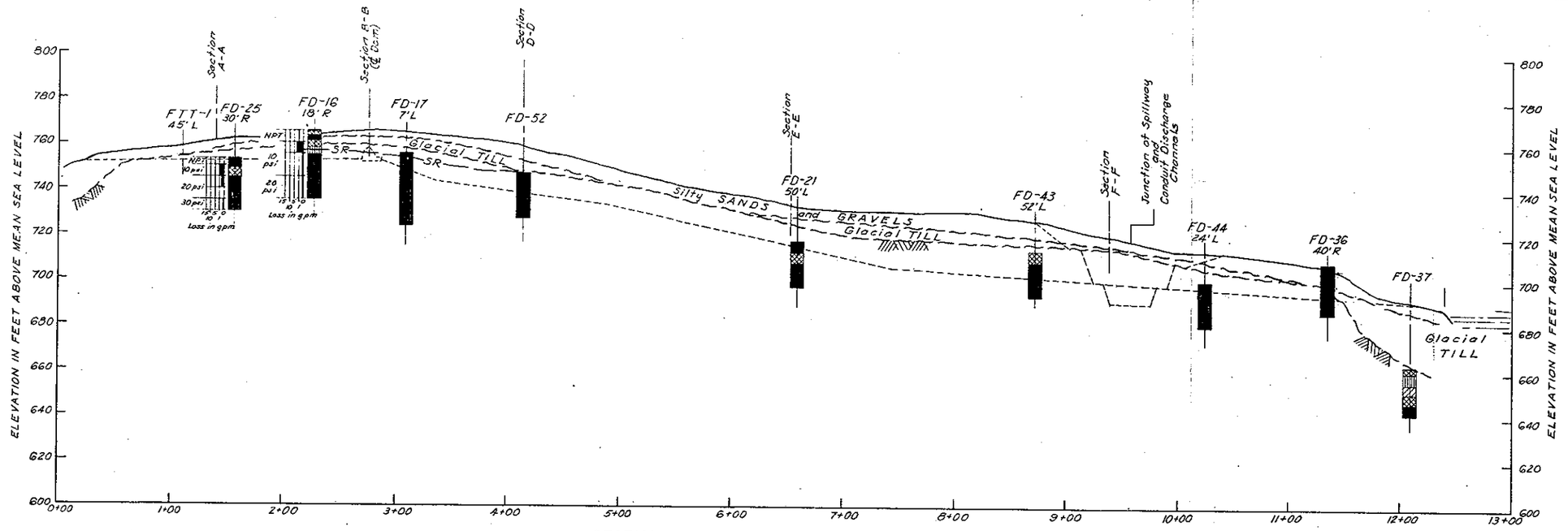
DRAWING NUMBER

SHEET

PLATE NO. 6-3

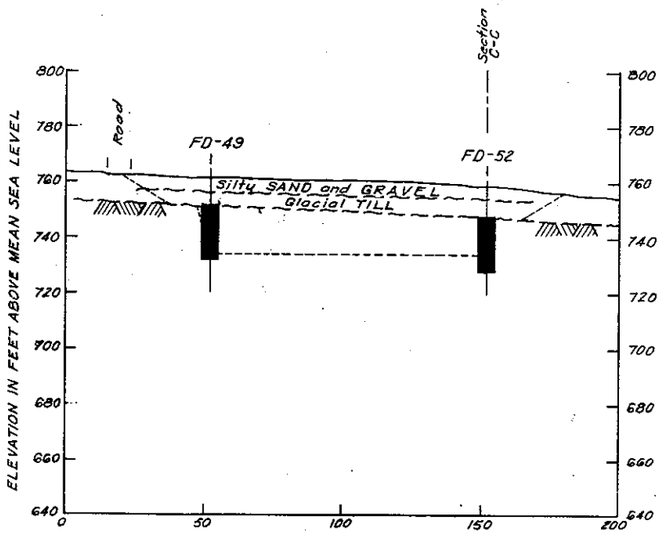
CORPS OF ENGINEERS

U. S. ARMY



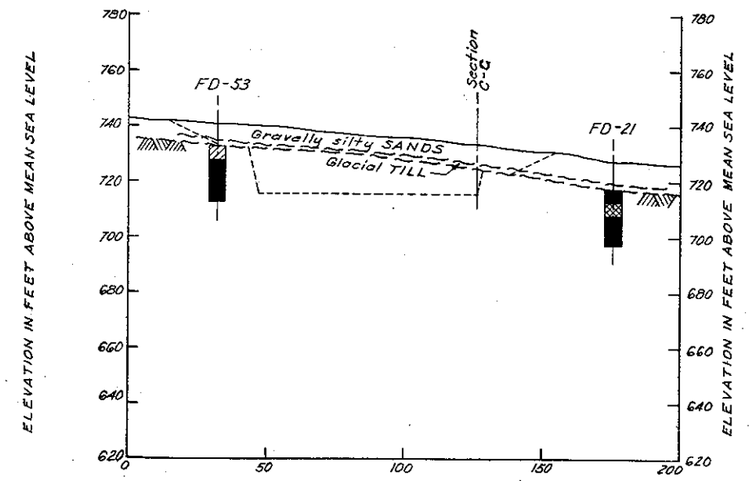
SECTION C-C OUTBOARD SIDE OF SPILLWAY

(LOOKING TOWARD RIVER)



SECTION D-D STA. 5+75 SPILLWAY ℄

(LOOKING UPSTREAM)



SECTION E-E STA. 8+20 SPILLWAY ℄

(LOOKING UPSTREAM)

NOTES

For Record of Foundation Explorations, see Plates No. 6-6, 6-7, 6-8 and 6-9.

For Location of Geologic-Log Sections, see Plate No. 6-2.

For Legend of Core Borings in Rock and applicable Notes, see Plate No 6-3.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY C.A.M. | DR. BY R.D.G. | CK. BY R.C.G.

SUBMITTED

HEAD, GEOLOGY SECTION / PROJECT ENGINEER

APPROVAL RECOMMENDED

CHIEF, FOUN. & MAT'LS BRANCH
APPROVAL RECOMMENDED

CHIEF, PLANS & SPEC'S BRANCH

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

CONANT BROOK DAM
GEOLOGIC-LOG SECTIONS - SPILLWAY
CHICOPEE RIVER, MASSACHUSETTS

APPROVED

CHIEF, ENGINEERING DIVISION

DATE JULY 1963

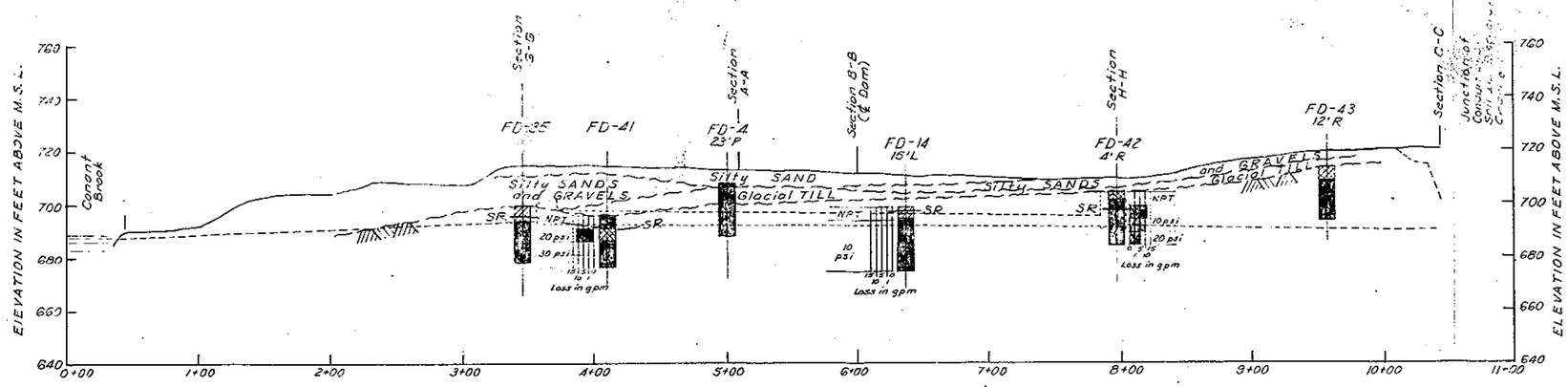
SCALE

SPEC. NO CIV. ENG.-78-046

DRAWING NUMBER

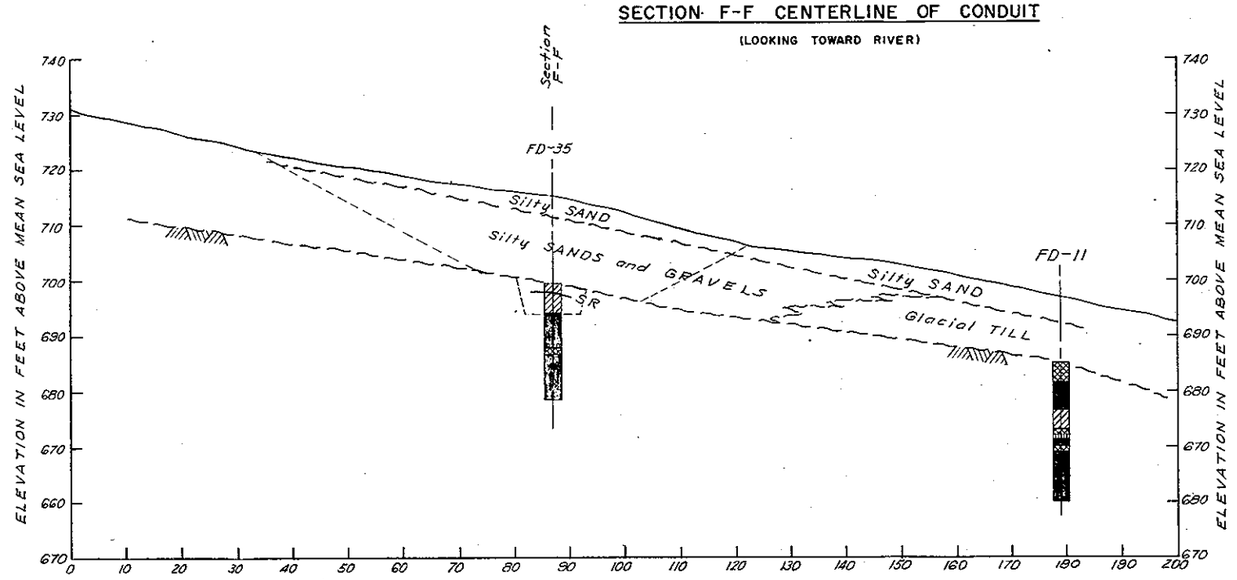
SHEET

PLATE NO. 6-4



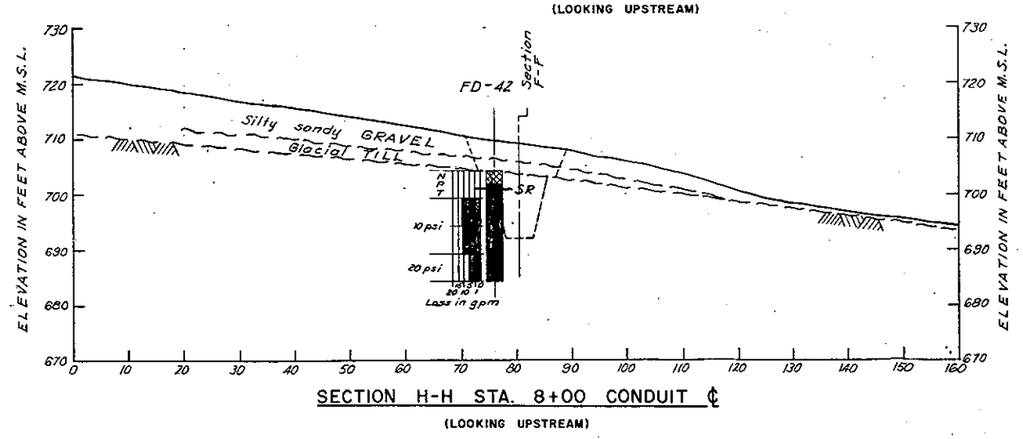
SECTION F-F CENTERLINE OF CONDUIT

(LOOKING TOWARD RIVER)



SECTION G-G STA. 3+50 CONDUIT ℄

(LOOKING UPSTREAM)



SECTION H-H STA. 8+00 CONDUIT ℄

(LOOKING UPSTREAM)

NOTES

For Record of Foundation Explorations, see Plates No. G-6, G-7, G-8 and G-9.

For Location of Geologic-Log Sections, see Plate No G-2

For Legend of Core Borings in Rock and applicable Notes, see Plate No. G-3.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY C.A.M.	DR. BY R.D.B.	CK. BY R.C.G.

SUBMITTED: Head, Geology Section
PROJECT ENGINEER:
APPROVAL RECOMMENDED: Chief, Eng. & Const. Branch
APPROVAL RECOMMENDED: Chief, Plans & Spec's Branch

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN

CONANT BROOK DAM

GEOLOGIC-LOG SECTIONS-CONDUIT

CHICOPEE RIVER, MASSACHUSETTS

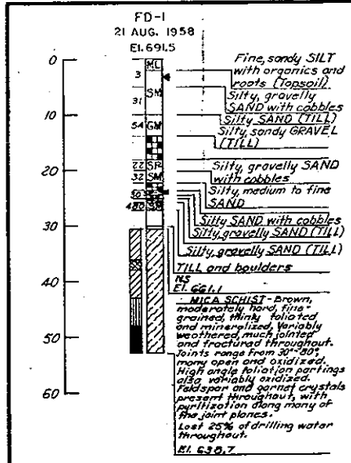
APPROVED: Chief, Engineering Division
DATE: JULY 1963

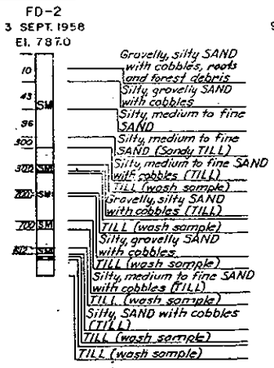
SCALE
SPEC. NO CIV. ENG.-19-068
DRAWING NUMBER
SHEET

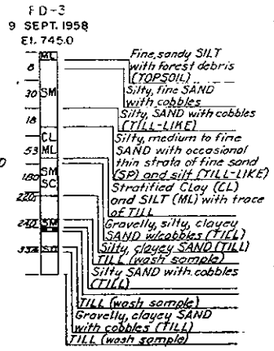
PLATE NO. 6-5

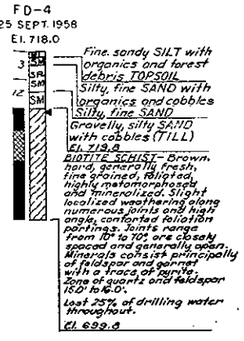
CORPS OF ENGINEERS

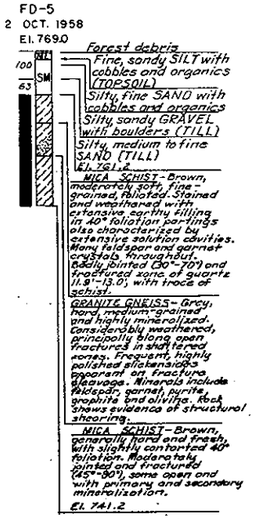
U. S. ARMY

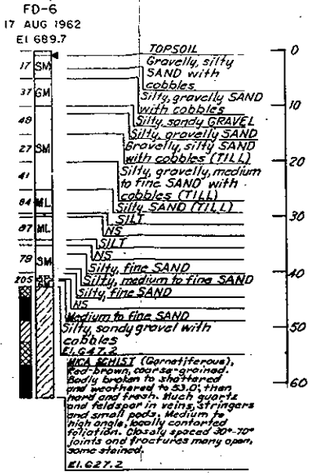








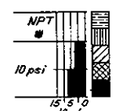




LEGEND FOR GRAPHIC LOGS

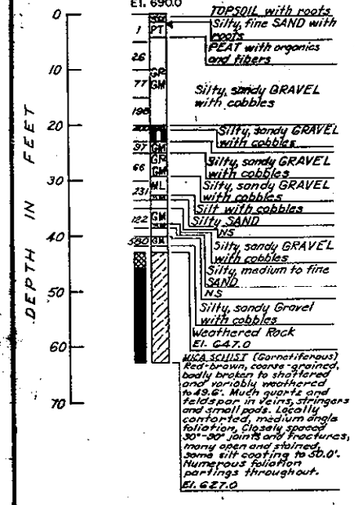
FD-1 Foundation Test Boring
FT-1 Foundation Test Pit
FTT-1 Foundation Test Trench
(OW) Observation well installed
17 AUG. 1963 Date exploration completed
El. 689.7 Elevation of ground surface during time of exploration

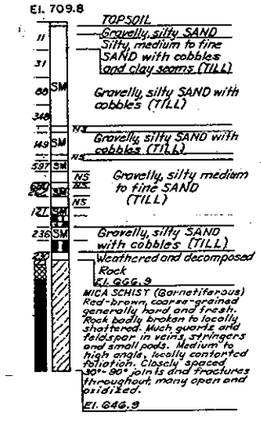
Maximum artesian head
Subsurface water level in boring at time of exploration.
Range of subsurface water during period of observation.
Artesian flow encountered
SM Group letter symbol according to Unified Soil Classification System.
NR No Recovery or unsatisfactory soil samples recovered.
NS Not Sampled, Hole advanced by Core-drilling, blasting and/or wash boring due to operational difficulty.
U Bottom of observation well.
Sampling in overburden by core-drilled method.
CD Blows per foot of penetration considered most representative for each sample drive using a 300 to 350 pound hammer with a free fall of about 18" on 1½" I.D. or 2"O.D., 2"I.D. or 2½"O.D. and/or 2½"I.D. or 3"O.D. sizes sample spoon equipped with a beveled and sharpened drive shoe.
25 Blow counts not recorded or not considered representative
Cobble or boulder (Core-drilled)
Cobbles or boulders, continuous or nested (Core-drilled and/or labeled and charged)
El. 475.7 Elevation of bedrock surface
Rock symbol
El. 455.7 Elevation bottom of exploration

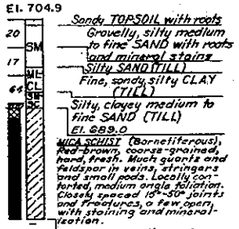


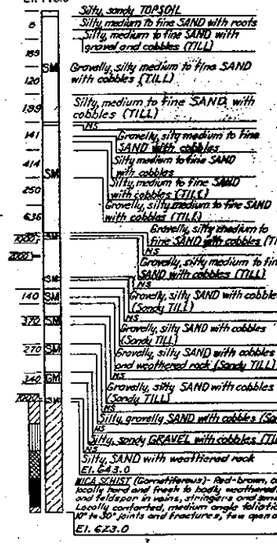
Rock core recovery 0 - 25% "
Rock core recovery 25 - 50%
Rock core recovery 50 - 75%
Rock core recovery 75 - 90%
Rock core recovery 90 - 100%

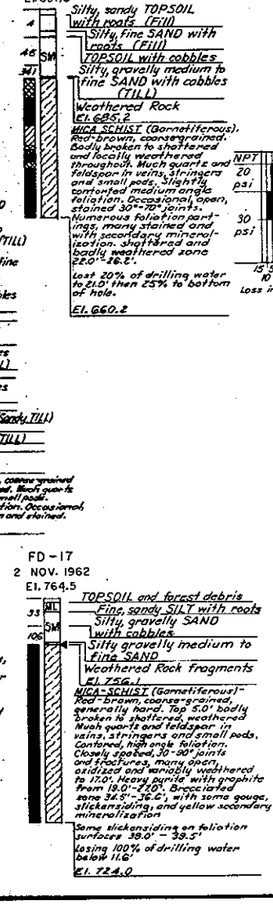
NPT No Pressure Test Performed. Asterisk denotes that section could not be sealed for testing.
10 psi Constantly maintained pressure for 1 to 5 minutes
Volume loss in gallons per minute under constant pressure, tested continuously in 5 foot sections.
Scale expanded from 0 gpm to 1 gpm for clarification of low flow losses.

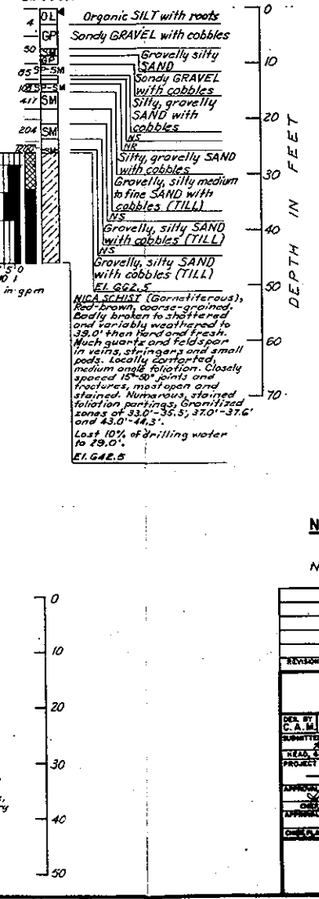


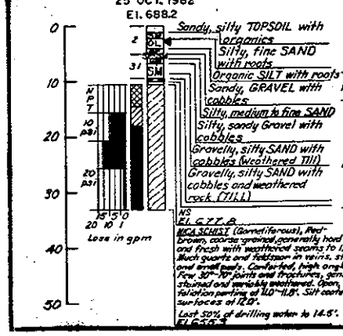


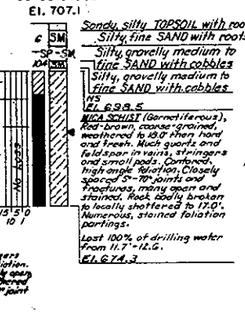


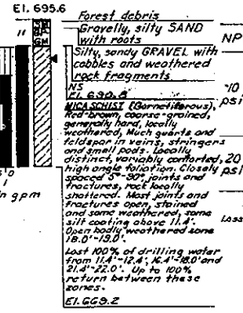


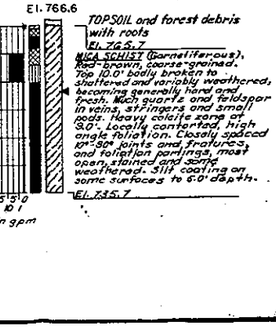












NOTES

Elevations refer to Mean Sea Level Datum.
For Location of Foundation Explorations, see Plates No. G-1 and G-2.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY C.A.M. | DR. BY R.D.B. | CH. BY R.C.G.
SUBMITTED M.C. Hardy
HEAD, GEOLOGY SECTION
PROJECT ENGINEER
APPROVED (DIVISION ENGINEER)
CHIEF, ENGINEERING DIVISION
APPROVED (RECOMMENDED)
CHIEF, PLANS & SURVEYS BRANCH

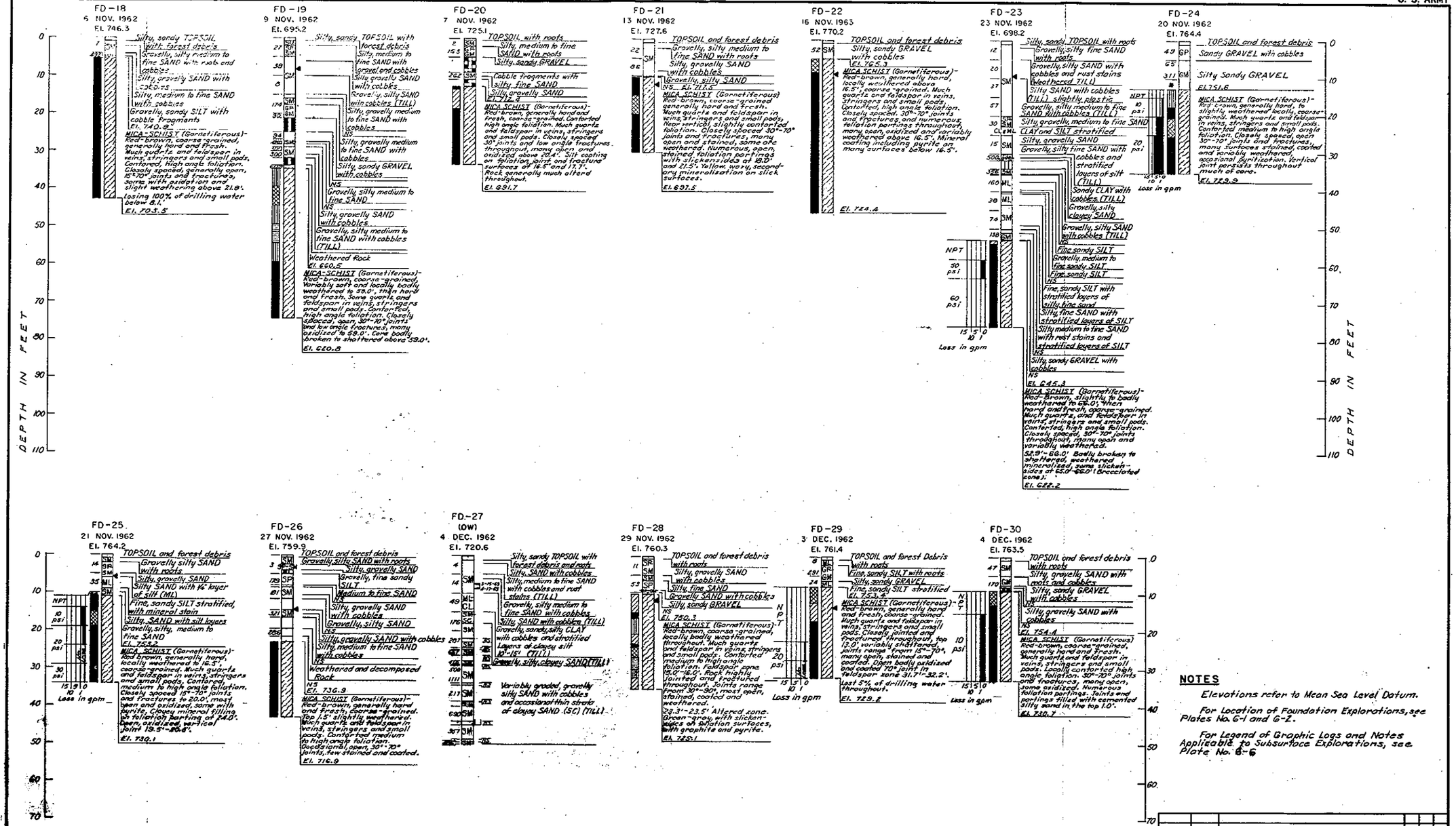
CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN
CONANT BROOK DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 1
CHICOPEE RIVER, MASSACHUSETTS
APPROVED DATE JULY 1963
CHIEF, ENGINEERING DIVISION

SCALE
SPEC. NO. DA-19-090-CIVENG-63-
DRAWING NUMBER
SHEET

PLATE NO. 6-3

CORPS OF ENGINEERS

U. S. ARMY



NOTES

Elevations refer to Mean Sea Level Datum.

For Location of Foundation Explorations, see Plates No. 6-1 and 6-2.

For Legend of Graphic Logs and Notes Applicable to Subsurface Explorations, see Plate No. 6-6

REVISION	DATE	DESCRIPTION	BY

(U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY C.A.M. | DR. BY R.D.B. | CK. BY R.C.G.

SUBMITTED — HEAD, GEOLOGY SECTION — PROJECT ENGINEER

APPROVAL RECOMMENDED — CHIEF, PLANS & SPEC'S BRANCH

APPROVAL RECOMMENDED — CHIEF, PLANS & SPEC'S BRANCH

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN
CONANT BROOK DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 2
CHICOPEE RIVER, MASSACHUSETTS

APPROVED — CHIEF, ENGINEERING DIVISION

DATE JULY 1963

SCALE

SPEC. NO CW, ENR.-19-048

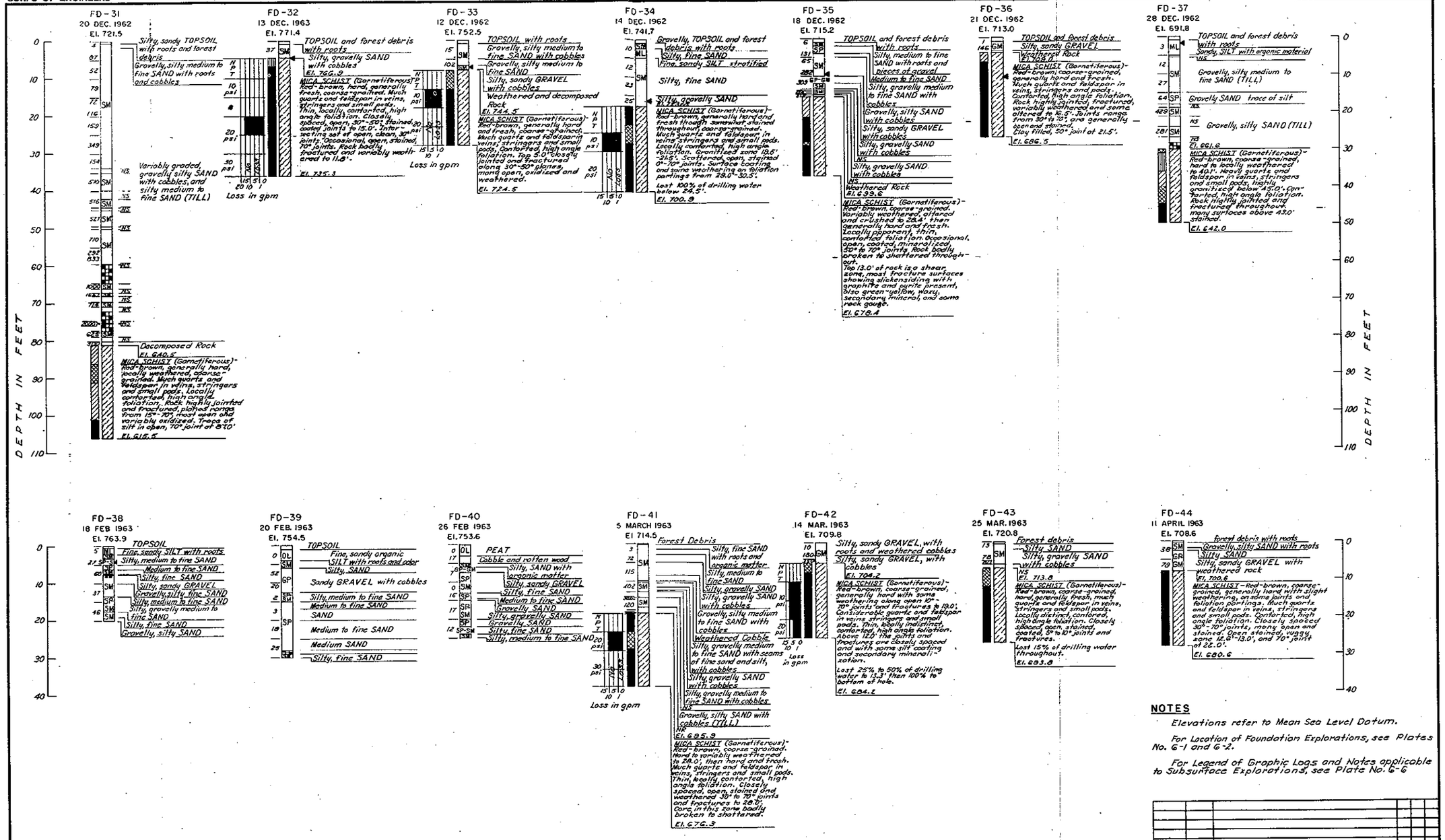
DRAWING NUMBER

SHEET

PLATE NO. 6-7

CORPS OF ENGINEERS

U. S. ARMY



NOTES

Elevations refer to Mean Sea Level Datum.

For Location of Foundation Explorations, see Plates No. 6-1 and 6-2.

For Legend of Graphic Logs and Notes applicable to Subsurface Explorations, see Plate No. 6-6

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY	CK. BY
C. A. M.	R. D. B.	R. C. G.

SUBMITTED
HEAD, GEOLOGY SECTION
PROJECT ENGINEER

APPROVAL RECOMMENDED
CHIEF, PLANS & SPECS BRANCH

APPROVAL RECOMMENDED
CHIEF, PLANS & RPTS BRANCH

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN
CONANT BROOK DAM
RECORD OF FOUNDATION EXPLORATIONS NO. 3
CHICOPEE RIVER, MASSACHUSETTS

APPROVED
CHIEF, ENGINEERING DIVISION

DATE JULY 1963

SCALE

SPEC. NO CIV. ENG.-19-046

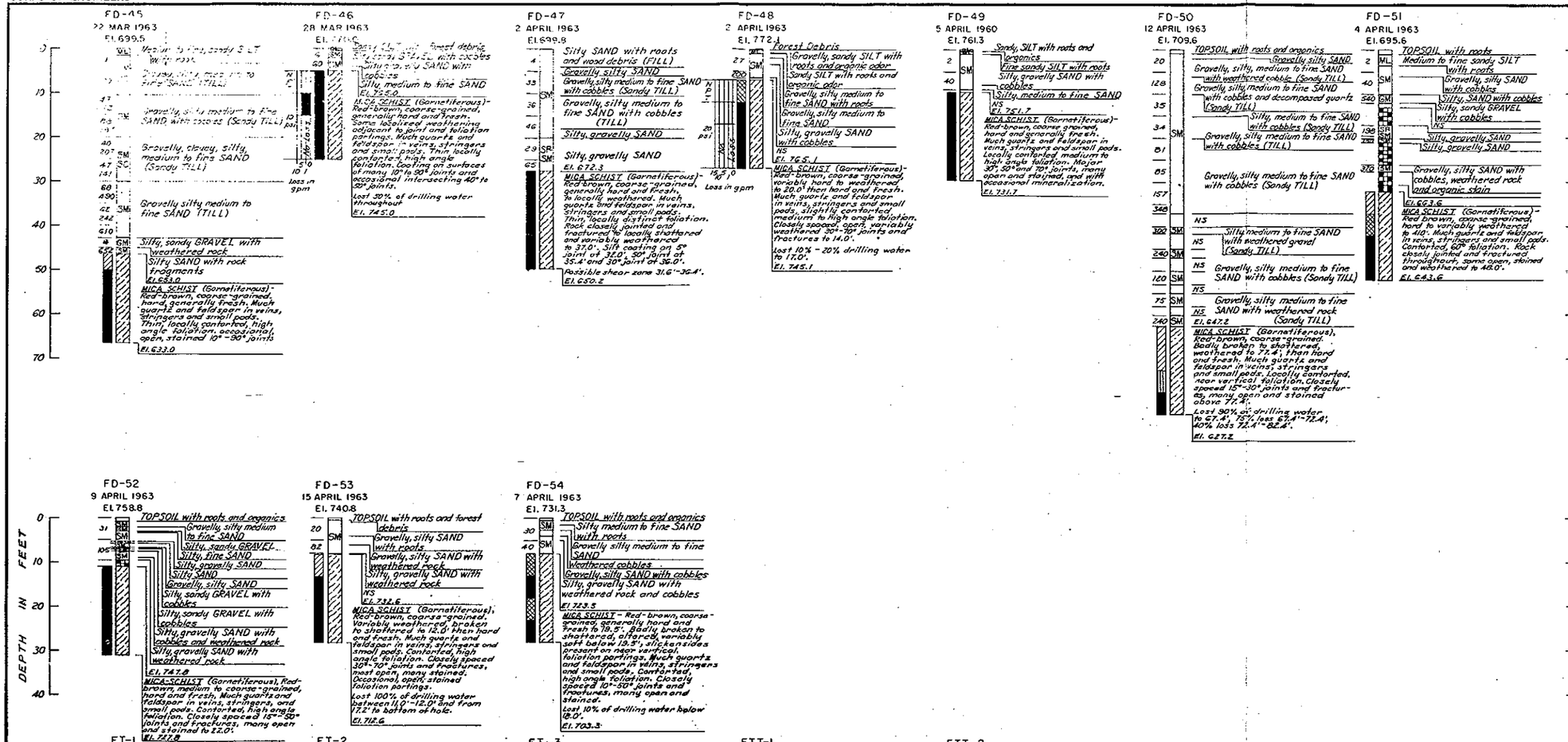
DRAWING NUMBER

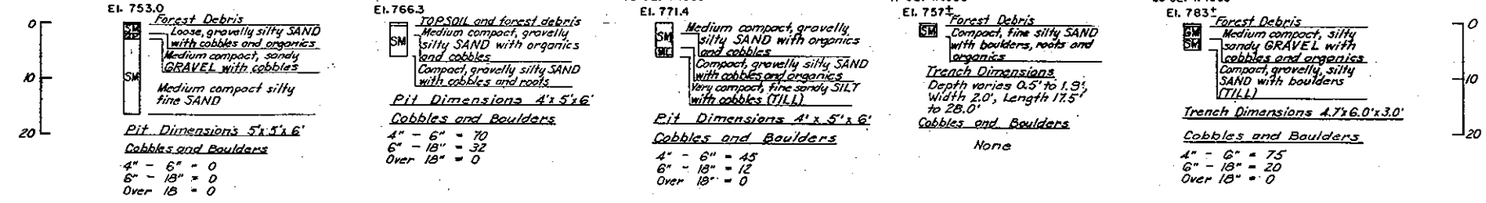
SHEET

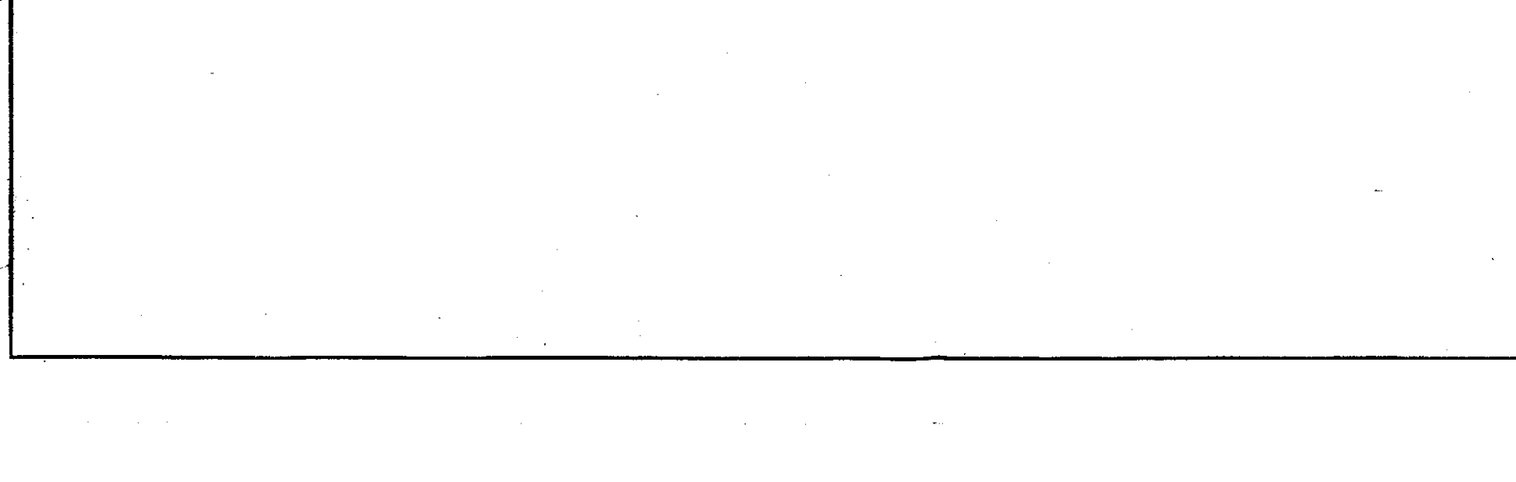
PLATE NO. 6-8

CORPS OF ENGINEERS

U. S. ARMY







NOTES

Elevations refer to Mean Sea Level Datum.

For Location of Foundation Explorations see Plates No. 6-1 and 6-2.

For Legend of Graphic Logs and Notes applicable to Subsurface Explorations, see Plate No. 6-6.

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS

DES. BY	DR. BY	CK. BY
C.A.M.	R.D.B.	R.C.G.

SUBMITTED
HEAD, GEOLOGY SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
CHIEF, PGA & SOILS BRANCH
APPROVAL RECOMMENDED
CHIEF, PLANS & RPTS BRANCH
APPROVED
CHIEF, ENGINEERING DIVISION

CONNECTICUT RIVER FLOOD CONTROL
CHICOPEE RIVER BASIN
CONANT BROOK DAM
RECORD OF FOUNDATION EXPLORATIONS
NO. 4
CHICOPEE RIVER, MASSACHUSETTS
DATE JULY 1963

SCALE
SPEC. NO CIV. ENG. -19-016
DRAWING NUMBER
SHEET

PLATE NO. 6-9